Solar thermal and wind energy applications: case-study on a small village in Spain

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INTRODUCTION

Description of the problem

1. Climate change, Global warming, Scarcity of renewable energy resources
2. Renewed interest in the development of sustainable and energy independent communities (i.e. small villages)

Purpose of the work

A technical analysis for the supply of heating and electricity to the Spanish village of Urueña using biomass and other local renewable sources within the design of a district heating system for covering the total thermal needs of the village.

CASE STUDY

Description

- Small village of Urueña, Valladolid, Spain (Iberian peninsula)
- 224 inhabitants, 160 houses

Technical data

- Total thermal losses: \( \Phi_T = 1224.2 \) kW (for the whole village)
- Annual energy consumption: \( Q_{h,y1} = 45.2 \) GJ/year (one-floor)/\( Q_{h,y2} = 79.8 \) GJ/year (two-floor)
- Estimated annual water consumption: \( Q_{w,\text{year}} = 481.1 \) GJ
- Capacity required: thermal energy requirements of the village:
  a. Solar heating system: Capacity: 27.6 kW for requirements of 242 MWh, installation of typical solar collectors (43 units)
  b. Biomass plant: \( \Phi_{b1} = 0.716 \) MW / Energy generated: \( Q_{y,b1} = 2823 \) MWh
  c. Oil boiler
  d. Thermal energy storage: combi hot water tank/ Capacity: \( Q_{w,\text{year}} = 481.063 \) GJ

- **Electricity system**: total annual consumption (160 houses): \( E_{ac} = 491.36 \) MWh
  Two alternative system configurations (Weibull distribution):
  1. System of 3 wind turbines: energy produced (yearly): 517.46 MWh covering the total consumption of the village
  2. System with a single large wind turbine: 400 kW

CONCLUSIONS

- District heating plant system: combination of generation technologies (electricity and thermal energy storage)
- Qualitative approach: to assess the environmental benefits in terms of CO2 emissions reduction
- Strong policy measures needed to revise the role and potential of rural areas

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